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COMPARATIVE SPINNING TESTS OF THE DIFFERENT GRADES OF ARIZONA-EGYPTIAN WITH SEA ISLAND AND SAKELLARIDIS EGYPTIAN COTTONS.

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CONTENTS.

Page.
Introduction ... 1
Purpose of the spinning tests ... 2
Mechanical conditions ... 2
Grade, staple, and price comparisons ... 3
Waste comparisons ... 4
Tensile strength comparisons ... 7
Bleaching, dyeing, and mercerizing ... 11
Difficulties in introducing a new variety of cotton ... 16
Comparative spinning tests of the crop of 1913–14 ... 17
Summary ... 18

INTRODUCTION.

The introduction and development of long-staple cotton in the Salt River Valley of Arizona is described fully in previous bulletins published by the United States Department of Agriculture.[1] With these publications available, the purpose of this bulletin will be to deal exclusively with the adaptability of this cotton for manufacturing purposes.

Not until the last few years has the production of Arizona-Egyptian cotton been sufficient in quantity to interest the manufacturer materially. The estimated production figures are as follows: In 1912, 280 bales; in 1913, 2,200 bales; in 1914, 6,187 bales. On account of abnormal conditions, the acreage for 1915 was reduced approximately 50 per cent with a corresponding reduction in the yield. Information, however, is at hand, which indicates an increase in acreage for the season of 1916.

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[1] See Bureau of Plant Industry Bulletin No. 128, "Egyptian Cotton in the Southwestern United States;" Department Bulletin No. 38, "Seed Selection of Egyptian Cotton;" Department Bulletin No. 332: "Community Culture of Egyptian Cotton in the United States," and the list of publications given on the last page of this bulletin. For grade factors see Department Bulletin No. 311, "The Handling and Marketing of the Arizona-Egyptian Cotton of the Salt River Valley."

NOTE.—This bulletin is of interest to the growers, cotton merchants, manufacturers and dealers in Arizona-Egyptian, Sea Island, and Sakellaridis Egyptian cottons and cotton yarns.

PURPOSE OF THE SPINNING TESTS.

Because of the remarkable increase in the production of this cotton, it has seemed advisable to accumulate reliable data relative to the character of Arizona-Egyptian cotton for manufacturing purposes. This cotton closely resembles the Sakellaridis Egyptian cotton in color, character, and length of fiber and in many respects compares favorably with the Sea Island cotton of Georgia and Florida. Spinning tests have been conducted by the Department of Agriculture to develop information along the following lines: First, the different grades of Arizona-Egyptian cotton were compared with each other as to their spinning qualities, viz, waste, tensile strength, bleaching, mercerization, dyeing and finishing qualities; and, second, the Arizona-Egyptian cotton was compared with Sakellaridis Egyptian and Sea Island cottons.

As these cottons can be substituted for each other to some extent in the manufacture of certain classes of goods, it is believed that reliable spinning tests will prove of general interest in bringing out the individual merits of these varieties.

Tests [1] were conducted on the 1914 crop during the summer of 1915 on the following lots of cotton, namely, four bales of Arizona-Egyptian cotton—one of each of the grades, Extra, Choice, Standard, and Medium; three bales of Sakellaridis Egyptian cotton, shipped from Alexandria, Egypt, marked MERR, CONN, and EDM, of the grades Good, Fully Good Fair, and Fair; and two bales of Sea Island cotton shipped from Blackshear, Ga., of the grades Fancy and Extra Choice. The bales of Sea Island cotton originated no doubt in the interior and were slightly different in character from the longer length staples of Sea Island cottons grown on the islands and the coast. One hundred pounds of each of these bales were used in making the tests.

MECHANICAL CONDITIONS.

In each test the cotton was opened and left standing overnight before being fed into the first machine. The machines were kept in good working order and sufficient time was taken between each run to clean them thoroughly. Total weights were taken immediately before and after the cotton was fed into the opener, finisher, cards and combers, respectively. Each kind of cotton up to the slubber was run through the same machines and subjected to practically the same speeds, settings, drafts, etc. In the manufacture of yarn, numbers 10's, 20's, 30's, 40's, 50's, 60's, 80's and 100's, from each kind of cotton, the same weight of lap and sliver was used up to the slubber, This was done in order to have the cleaning machinery operate under exactly the same conditions for each kind of cotton used, so that the waste percentages might be comparable.

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[1] Through the courtesy of Mr. William E. Hatch, President, these tests were conducted at the New Bedford Textile School, New Bedford, Mass., under the supervision of Mr. Fred Taylor. Mr. W. S. Dean was directly in charge of the work, assisted by Messrs. J. J. W. Cooper and T. C. Adams.

The different lots of cotton were run on the same fly or roving frames and spinning frames throughout for the different numbers of yarn; that is, all cotton going into any certain number of yarn was subjected to the treatment of the same machines, and, where possible, the different lots were placed and run simultaneously through each process. Table I gives the respective drafts used in these machines.

TABLE I.—*Drafts used in the manufacture of each number of yarn.*

Numbers.	Slubber.	First intermediate.	Second intermediate.	Jack frame.	Spinning frame.
10's...	3	4	5	....	8
20's...	3	4.5	6	....	11.9
30's...	3	4	5	6	8.26
40's...	3	4	5	6.42	10
50's...	3	4.17	5.5	7	10
60's...	3	4.5	6	7.12	10
80's...	3.63	5	6	7	10
100's...	4	5.30	6.25	7.25	10

While the cotton was being manufactured, the humidity conditions were kept as nearly constant as possible. Records were taken hourly and the humidifiers were regulated accordingly. Records were taken also every thirty minutes during the time the tensile strength tests were being conducted. The desired point of relative humidity was 55 per cent in the raw cotton and picker rooms, 55 to 60 per cent in the card room, 60 to 65 per cent in the spinning room, and 65 per cent in the yarn-testing room. Moisture tests were made also on samples of cotton selected from each place in the processes where the stock was weighed, and it was found that the differences in the percentages of moisture were comparatively small.

The spinning qualities of the different lots of cotton were judged in the following manner:

A broken end on a spinning frame was not pieced up until determinations were made as to the causes of the breakage. All ends breaking down, unless due to some mechanical defect, were charged against the particular grades or lots in which they occurred, and notations were made as to the amount of fly waste from the different lots.

There was no conclusive evidence of superiority in any one lot over any other in spinning. In a number of cases, the bobbins of each lot filled up on the spinning frames without an end breaking down.

GRADE, STAPLE, AND PRICE COMPARISONS.

In order to understand better the comparative relations between the lots of cotton to be used, samples were presented to a committee of cotton specialists of the Office of Markets and Rural Organization. It was thought that, judging from the general appearance of the different cottons from the standpoint of grade, the following comparisons would be fair:

Extra Arizona-Egyptian to be compared with Fancy Sea Island.

Choice Arizona-Egyptian to be compared with Extra Choice Sea Island, also against Good Sakellaridis Egyptian.

Standard Arizona-Egyptian to be compared with Fully Good Fair Sakellaridis Egyptian.

Medium Arizona-Egyptian to be compared with Fair Sakellaridis Egyptian.

This committee estimated the length of staple as shown in Table II.

TABLE II.—*Length of staple of cotton used in the tests.*

Arizona-Egyptian.		Sea Island.		Sakellaridis Egyptian.	
Grade.	Inches.	Grade.	Inches.	Grade.	Inches.
Extra	1½	Fancy	$1\frac{9}{16}$	Good	$1\frac{7}{16}$
Choice	1½	Extra Choice	$1\frac{9}{16}$	Fully good fair	$1\frac{7}{16}$
Standard	1½			Fair	$1\frac{7}{16}$
Medium	1½				

Individual fibers of these cottons were also measured by the projection device originated by Dr. N. A. Cobb of this department, and it was found that the ratio of lengths between the estimated lengths and the actual measurements was relatively uniform.

Samples of this cotton were sent to certain reputable cotton brokers who deal in staple cotton to ascertain the comparative commercial value of each bale on the same day. Data were given these brokers regarding the origin of each bale of cotton, so that all factors influencing the commercial value could be considered. Table III shows the result of this inquiry.

TABLE III.—*Price per pound of cotton used in the tests.*

Arizona-Egyptian.		Sea Island.		Sakellaridis Egyptian.	
Grade.	Price per pound.	Grade.	Price per pound.	Grade.	Price per pound.
Extra	$0.21	Fancy	$0.21½	Good	$0.21½
Choice	.20¼	Extra choice	.20½	Fully good fair	.20½
Standard	.19¼			Fair	.19¾
Medium	.18				

WASTE COMPARISONS.

The results obtained from the tests, already described, to determine the amount of waste in each kind and variety of cotton are shown in Table IV. This table gives the waste percentages based on the amount of cotton fed into each machine. The tare on the bales of cotton was not included in any case.

TABLE IV.—*Waste percentages based on net amount of cotton fed into each machine.*

Machines.	Kind of waste.	Arizona-Egyptian.				Sea Island.		Sakellaridis Egyptian.		
		Extra.	Choice.	Standard.	Medium.	Fancy.	Extra choice.	Good.	Fully good fair.	Fair.
Opener.....	Visible:									
	Dust room...........	0.25	0.187	0.375	0.375	0.319	0.312	0.521	0.314	0.189
	Opener, motes and fly.	.312	.25	.25	.187	.510	.312	.260	.251	.757
	Breaker, motes and fiy	.687	.562	.937	.749	.765	.625	.911	1.067	.567
	Total visible.......	1.249	.999	1.562	1.311	1.594	1.249	1.692	1.632	1.513
	Invisible.................	.937	....	.5	.5	1.531	.937	1.043	1.444	.946
	Total visible and invisible.........	2.186	.999	2.062	1.811	3.125	2.186	2.735	3.076	2.459
Finisher....	Visible:									
	Dust room...........	.067	.068	.068	.068	.137	.067	.077	.069	.07
	Motes and fly........	.674	.617	.546	.751	.617	.535	.850	1.111	1.052
	Total visible.......	.741	.685	.614	.819	.754	.602	.927	1.180	1.122
	Invisible.................	.134	a.411	.341	.341	....	.267	.540	.069	.140
	Total visible and invisible.........	.875	.274	.955	1.160	.754	.869	1.467	1.249	1.262
Cards......	Visible:									
	Flat strippings.......	3.233	3.832	3.905	3.574	5.203	5.702	3.925	4.804	4.705
	Cylinder and doffer strippings..........	1	1.179	1.252	1.216	1.069	1.140	1.373	1.552	1.47
	Motes and fly........	.769	1.031	1.031	1.216	.855	.926	1.275	1.551	1.837
	Total visible.......	5.002	6.042	6.188	6.006	7.127	7.768	6.573	7.907	8.012
	Invisible.................	.384	.368	.442	.988	a.213	a.427	1.472	a.369	1.397
	Total visible and invisible.........	5.386	6.410	6.630	6.994	6.914	7.341	8.045	7.538	9.409
Combers...	Visible.....................	11.127	11.764	12.811	12.406	13.675	14.529	15.981	16.362	16.408
	Invisible.................	a.867	.110	a.088	a.093	.756	a.2	a.822	.435	a.257
	Total visible and invisible.........	10.260	11.874	12.723	12.313	14.431	14.329	15.159	16.797	16.151

[a] Invisible gain, not loss, as result of weather conditions.

There seems to be no significant relationship between the grade of Arizona-Egyptian cotton and the percentage of waste or between the variety of cotton and the amount of waste discarded, when the percentage of waste is considered at any of the individual processes of manufacture. Arizona-Egyptian cotton, however, shows more uniformity in this respect than any other, with the Sea Island second. By referring to Table V which represents the total amount of waste taken from the different processes computed on the original amount fed into the opener, it will be noticed that there seems to be some uniformity of relationship between the percentages of waste and the different grades of Arizona-Egyptian cotton, ascending in order of grade, as follows: Extra, 17.69 per cent; choice, 18.56 per cent; standard, 20 per cent; and medium, 20.90 per cent. The average percentage of waste of each variety is, Arizona-Egyptian cotton, 19.28; Sea Island, 23.23; and Sakellaridis, 26.57.

TABLE V.—*Total visible and invisible waste.*

[Percentages based on the original amount of cotton fed into the opener.]

Machines.	Arizona-Egyptian.				Sea Island.		Sakellaridis Egyptian.		
	Extra.	Choice.	Standard.	Medium.	Fancy.	Extra choice.	Good.	Fully good fair.	Fair.
Pickers	3.05	1.27	2.99	2.95	3.86	3.04	4.17	4.29	3.69
Cards	5.22	6.32	5.47	6.83	6.65	7.12	7.72	7.22	9.06
Combers	9.42	10.97	11.54	11.12	12.91	12.89	13.47	14.87	15.22
Total	17.69	18.56	20.00	20.90	23.42	23.05	25.36	26.38	27.97

Judging from the general appearance and grade of Arizona-Egyptian cotton against similar grades of the other cottons (see comparisons on p. 4) the spinning values, as shown by the amount of waste discarded in the manufacturing processes, apparently, are not evident in the raw cotton. The grades, as previously arranged for comparison, seem to be equal in value, but when subjected to the manufacturing processes, the cottons prove to be decidedly unequal, the difference being in favor of the Arizona-Egyptian cotton as follows:

Extra Arizona-Egyptian shows 5.73 per cent less waste than Fancy Sea Island.

Choice Arizona-Egyptian shows 4.49 per cent less waste than extra choice Sea Island.

Choice Arizona-Egyptian shows 6.80 per cent less waste than good Sakellaridis Egyptian.

Standard Arizona-Egyptian shows 6.38 per cent less waste than fully good fair Sakellaridis Egyptian.

Medium Arizona-Egyptian shows 7.07 per cent less waste than fair Sakellaridis Egyptian.

Choice Arizona-Egyptian is the only individual bale of cotton that is compared with both Sea Island and Sakellaridis cotton. The Arizona-Egyptian shows 4.49 per cent less waste than the Sea Island, and the Sea Island shows 2.31 per cent less waste than the Sakellaridis. These figures indicate very clearly that of the three lots tested the Arizona-Egyptian was considerably less wasty than Sea Island, and Sea Island considerably less than the Sakellaridis. Figure 1 represents graphically these waste percentages.

By referring again to the relative prices of these different cottons, as given in Table III, it will be seen that there was a relation between the prices and the grades, but there was no relation whatever between the prices of the different lots of cotton and the percentages of waste discarded from each lot in the manufacturing processes.

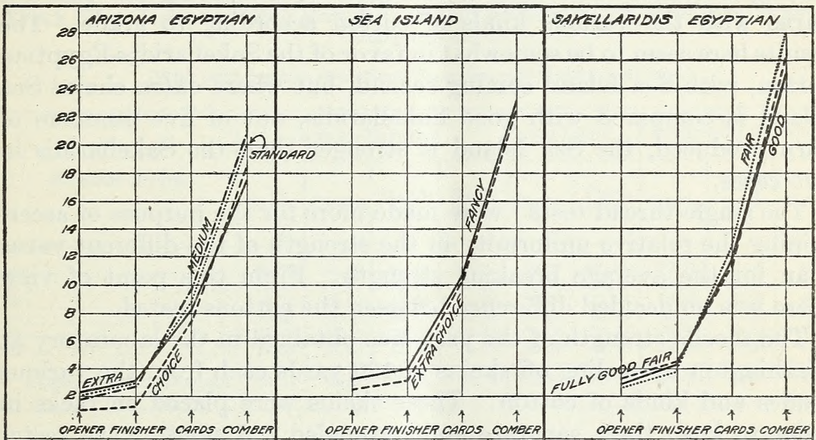
Rather a reverse condition was demonstrated, that is, the Arizona-Egyptian cotton that was represented as being of least value in cents per pound was in reality the cotton that discarded the least waste in the manufacturing processes. This comparison of equivalent grades (see p. 4) will be found in Table VI.

TABLE VI.—*Prices of the different grades of each lot of cotton in comparison with the percentages of waste discarded.*

[Bales arranged in groups according to the apparent grade relation of the different lots.]

	Arizona extra.	Sea Island fancy.	Arizona choice.	Sea Island extra choice.	Sakel-laridis good.	Arizona stand-ard.	Sakel-laridis fully good fair.	Arizona me-dium.	Sakel-laridis fair.
Price of cotton	$0.21	$0.21½	$0.20¼	$0.20½	$0.21½	$0.19¼	$0.20½	$0.18	$0.19¾
Percentage of waste	17.69	23.42	18.56	23.05	25.36	20.00	26.38	20.90	27.97

It should be borne in mind that all the cotton represented as waste is not actually lost, but the greater part of it is reworked in the manufacture of cheaper goods.



EXTRA	2.19	3.05	8.27	17.69	F.	3.13	3.86	10.51	23.42	GOOD	2.74	4.17	11.89	25.36
CHOICE	1.00	1.27	7.59	18.56	E.C.	2.19	3.04	10.16	23.05	F.G.F.	3.08	4.29	11.51	26.38
STANDARD	2.06	2.99	8.46	20.00						FAIR	2.46	3.69	12.75	27.97
MEDIUM	1.81	2.95	8.78	20.90										

FIG. 1.—Progressive waste percentages of Arizona-Egyptian, Sea Island, and Sakellaridis Egyptian cottons.

TENSILE STRENGTH COMPARISONS.

In order to ascertain the difference in tensile strength between the grades of Arizona-Egyptian cotton and between Arizona-Egyptian, Sakellaridis Egyptian, and Sea-Island cottons, there were manufactured from each of these the following numbers of yarn: 10's, 20's, 30's, 40's, 50's, 60's, 80's, and 100's. The slight variations in the numbers of yarn were standardized on a weight basis. A portion of this cotton yarn was spun with two twist constants,[1] viz, 3.25 and 3.80.

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[1] Multiply the square root of the number of yarn by the constant to find the turns per inch of twist inserted in the yarn while spinning.

TABLE VII.—*Average breaking strength of single threads arranged in order, for comparison according to grade relations.*

[With twist per inch as indicated by the twist constant.]

Twist constant.	Numbers of yarn.	Extra Arizona.	Fancy Sea Island.	Choice Arizona.	Extra choice Sea Island.	Good Sakellaridis.	Standard Arizona.	Fully good fair Sakellaridis.	Medium Arizona.	Fair Sakellaridis.
3.80	30's	14.88	15.35	15.13	14.99	15.87	14.96	15.31	14.54	14.93
3.80	60's	4.29	4.53	3.88	4.50	4.35	4.18	4.60	4.10	4.25
3.25	60/2	11.54	12.02	10.85	11.43	11.91	11.85	12.25	12.08	12.01
3.80	100's	2.09	2.23	2.01	2.14	2.03	2.13	2.16	2.02	1.98
3.25	100's	1.77	2.02	1.82	1.92	2.00	1.94	1.78	1.92	1.69
Average	....	6.91	7.23	6.74	7.00	7.23	7.01	7.22	6.93	6.97

Table No. VII gives the results obtained from a single thread-testing machine. The table is arranged for comparing the different yarns with the various kinds of cotton according to grade. The results here seem to be somewhat in favor of the Sakellaridis-Egyptian cotton, with Sea Island coming second, but where extra choice Sea Island is compared with good Sakellaridis, out of five numbers of yarn produced, the Sea Island is stronger than the Sakellaridis in two cases.

The single-thread tests [1] were made more for the purpose of ascertaining the relative uniformity in the strength of the different yarns than for the average breaking strength. From this point of view there was no decided difference between the cottons tested.

The tensile strength of the yarn was obtained in the laboratory at Washington by reeling off skeins of 120 yards each from the various grades and kinds of cotton. These skeins were placed on racks in order to keep them separate and untangled. A power yarn tester was used, the downward stroke of the traverse moving at the rate of approximately 12 inches per minute. The humidity was kept as nearly constant as possible by taking records with a sling psychrometer every half hour and regulating the humidifier in the testing room. The desired point of relative humidity was 65 per cent. The skeins were taken one at a time in rotation from the different racks and broken. They were then weighed and the results recorded. This operation was repeated, usually 24 times, until the average breaking strengths shown in Tables VIII and IX were ascertained. From these tables it will be seen that there is no significant relationship between the breaking strength of the different grades of Arizona-Egyptian cotton.[2]

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[1] All single-thread tests were made at the New Bedford Textile School, New Bedford, Mass., by William Smith, principal in charge of the carding and spinning department of this school, who also furnished generous assistance throughout all these tests.

[2] See Bureau of Plant Industry Circular No. 110.

TABLE VIII.—*Average breaking strength in pounds per skein of 120 yards of the different numbers of yarn.*

[With twist per inch of 3.25 times the square root of number of yarn.]

Numbers of yarn.	Arizona-Egyptian.				Sea Island.		Sakellaridis Egyptian.		
	Extra.	Choice.	Standard.	Medium.	Fancy.	Extra choice.	Good.	Fully good fair.	Fair.
10's	352.66	332.29	329.60	314.37	306.08	320.14	341.99	330.43	301.24
20's	166.93	162.78	163.90	160.09	163.53	164.29	168.54	166.10	160.18
30's	100.09	96.54	96.88	95.89	101.78	97.55	98.88	100.41	96.44
40's	66.42	67.34	70.11	68.18	74.44	71.56	71.25	72.19	69.57
50's	50.49	49.22	48.34	48.62	53.56	50.27	51.84	50.79	48.78
80's	25.34	25.23	23.87	23.66	27.45	25.25	24.97	24.26	23.66
100's	17.07	17.89	17.96	17.34	20.25	18.78	18.14	18.56	15.24
Average breaking strength.	111.28	107.33	107.24	104.02	106.73	106.83	110.80	108.96	102.16

TABLE IX.—*Average breaking strength in pounds per skein of 120 yards of the different numbers of yarn.*

[With twist per inch of 3.8 times the square root of number of yarn.]

Numbers of yarn.	Arizona-Egyptian.				Sea Island.		Sakellaridis Egyptian.		
	Extra.	Choice.	Standard.	Medium.	Fancy.	Extra choice.	Good.	Fully good fair.	Fair.
30's	98.29	93.66	96.40	96.11	99.39	100.74	102.11	98.43	95.51
40's	73.43	70.13	70.12	67.21	72.70	70.17	73.04	72.23	68.72
50's	48.30	49.00	48.03	47.78	50.98	47.96	52.39	48.89	48.41
60's	39.63	39.11	39.45	39.06	41.93	38.78	41.25	39.49	39.09
80's	24.42	24.15	23.62	23.38	26.26	24.41	25.14	24.33	23.02
100's	17.82	18.00	17.81	17.23	20.24	18.48	18.08	18.61	16.82
Average breaking strength.	50.31	49.01	49.24	48.46	51.92	50.09	52.00	50.33	48.59

The same figures are used in Tables X and XI as were used in Tables VIII and IX, respectively. The latter tables, however, are designed to show the comparison in breaking strength between the different grades of the same variety of cotton, while the former tables show the comparison between the nearest equivalent grades of the different varieties of cotton. There is no uniformity in regard to the superiority of one of these lots of cotton over the other, considering the same number of yarn from the different lots. For instance, in Table X, of the four comparisons made with No. 10's yarn, Arizona-Egyptian was stronger than either of the other yarns for two of the comparisons, and Sakellaridis was stronger than the other yarns for the other two comparisons. Sea Island cotton for this number was apparently weaker than either, but by comparing 80's and 100's yarns, the conditions were practically reversed; that is, the Sea Island proved to be the strongest.

TABLE X.—*Average breaking strength in pounds per skein of 120 yards of the different numbers of yarn arranged to show comparison according to grade relations.*

[With twist per inch of 3.25 times the square root of the number of yarn.]

Numbers of yarn.	Extra Arizona.	Fancy Sea Island.	Choice Arizona.	Extra choice Sea Island.	Good Sakellaridis.	Standard Arizona.	Fully good fair Sakellaridis.	Medium Arizona.	Fair Sakellaridis.
10's	352.66	306.08	332.29	320.14	341.99.	329.60	330.43	314.37	301.24
20's	166.93	163.53	162.78	164.29	168.54	163.90	166.10	160.09	160.18
30's	100.09	101.78	96.54	97.55	98.88	96.88	100.41	95.89	96.44
40's	66.42	74.44	67.34	71.56	71.25	70.11	72.19	68.18	69.57
50's	50.49	53.56	49.22	50.27	51.84	48.34	50.79	48.62	48.78
80's	25.34	27.45	25.23	25.25	24.97	23.87	24.26	23.66	23.66
100's	17.07	20.25	17.89	18.78	18.14	17.96	18.56	17.34	15.24
Average breaking strength.	111.28	106.73	107.33	106.83	110.80	107.24	108.96	104.02	102.16

TABLE XI.—*Average breaking strength in pounds per skein of 120 yards of the different numbers of yarn arranged to show comparison according to grade relations.*

[With twist per inch of 3.8 times the square root of the number of yarn.]

Numbers of yarn.	Extra Arizona.	Fancy Sea Island.	Choice Arizona.	Extra choice Sea Island.	Good Sakellaridis.	Standard Arizona.	Fully good fair Sakellaridis.	Medium Arizona.	Fair Sakellaridis.
30's	98.29	99.39	93.66	100.74	102.11	96.40	98.43	96.11	95.51
40's	73.43	72.70	70.13	70.17	73.04	70.12	72.23	67.21	68.72
50's	48.30	50.98	49.00	47.96	52.39	48.03	48.89	47.78	48.41
60's	39.63	41.93	39.11	38.78	41.25	39.45	39.49	39.06	39.09
80's	24.42	26.26	24.15	24.41	25.14	23.62	24.33	23.38	23.02
100's	17.82	20.24	18.00	18.48	18.08	17.81	18.61	17.23	16.82
Average breaking strength	50.31	51.92	49.01	50.09	52.00	49.24	50.33	48.46	48.59

A careful analysis of these tensile strength tables discloses the fact that if comparisons of each kind of cotton and each number of yarn are made, the yarns manufactured from the Sakellaridis Egyptian cotton were proportionately stronger in the greatest number of cases, the yarns made from the Sea Island ranked second, while those made from Arizona-Egyptian cotton were lowest in tensile strength. There were, however, considerable variations, showing that first one kind of cotton and then another was superior in breaking strength on the different numbers of yarn. These variations might be taken as indications that each different kind of cotton is best adapted to certain numbers of yarn. It seems more probable, however, that these small differences would exist naturally in the manufacture of any two lots of cotton of even the same kind. The average of the tensile strength of all the different numbers of yarn with 3.25 as twist constant compared according to the grade arrangements given in Table X shows that in two cases out of four Arizona-Egyptian is the strongest, and in two cases Sakellaridis is the strongest. The average tensile strength of all the different numbers of yarn with twist constant of 3.80 as shown in Table XI shows that Sea Island is strongest in one case and Sakellaridis in three cases.

Referring again to page 6, it may be seen that the comparisons between the three grades of Arizona-Egyptian and Sakellaridis Egyptian show that the average differences in waste cotton were 6.80 per cent, 6.38 per cent, and 7.07 per cent, respectively, in favor of the Arizona-Egyptian. In the comparisons of the two grades of Sea Island cotton with Arizona-Egyptian there were differences of 4.49 per cent and 5.73 per cent, respectively, in favor of the Arizona-Egyptian.

The tensile strength of the yarns made from the different cottons is affected by the percentage of waste discarded. Therefore, where the differences in waste are so evident, in order to make a more comprehensive determination as to the comparative tensile strength, it would seem advisable to remove the same amount of waste from each kind of cotton.

BLEACHING, DYEING, AND MERCERIZING.

Investigations were made to ascertain the relative values of Arizona-Egyptian, Sea Island, and Sakellaridis cottons as to their bleaching, dyeing, and mercerizing qualities. These tests [1] were made upon both loose cotton and yarns. The following numerical designations arbitrarily represent the different grades and kinds of cotton. For example, 1 to 4 represents Arizona-Egyptian, 5 to 6, Sea Island, and 7 to 9, Sakellaridis.

Number.	Grade.	Kind.
1	Extra	Arizona-Egyptian.
2	Choice	Do.
3	Standard	Do.
4	Medium	Do.
5	Fancy	Sea Island.
6	Extra choice	Do.
7	Good	Sakellaridis Egyptian.
8	Fully good fair	Do.
9	Fair	Do.

BLEACHING LOOSE COTTON.

The different methods used in bleaching will be referred to as methods (a), (b), (c), (d), (e), (f), (A), and (B).

Method (*a*).—The cotton was bleached by treating it, without scouring, with a solution, obtained by the electrolysis of salt, containing 0.5 grams of chlorine per liter. In the future this solution will be designated as "electrolitic chlorine."

Method (*b*).—The cotton was scoured in a solution containing 1 gram of soda ash in each 10 cubic centimeters; then bleached as in (a).

Method (*c*).—The cotton was treated with 2 per cent acetic acid and bleached as in (a).

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[1] These tests were made at the New Bedford Textile School in the laboratory of the department of chemistry, by Everett H. Hinckley, professor in charge of this department.

Finally all the samples were blued with 0.001 per cent of blue violet acid dye.

These three methods represent the usual means taken to obtain white cotton for spinning, except that the quantity of bleaching agent used was reduced in order to magnify any variations in the results obtained.

Method (*d*).—The cotton was boiled two hours in a 10 per cent solution of soda ash and bleached cold in electrolitic chlorine containing 2 grams of chlorine per liter.

Method (*e*).—The cotton was treated as in (d) except that a chloride lime solution, containing 8 grams of chlorine per liter was used for the bleaching agent.

Method (*f*).—The cotton was treated as in (d) except that an alkaline solution of sodium peroxide equivalent to 15 grams of chlorine per liter was used.

After bleaching, all the samples were blued as in processes (a), (b), and (c). The above concentrations of bleaching agent represent those used in commercial practice to obtain equal bleaching results.

Method (*A*).—The cotton was treated cold for two hours in a 2-degree Twaddle solution of bleaching powder, containing 5.82 grams of chlorine per liter; rinsed with cold water; soured with 2 per cent solution of acetic acid; rinsed and antichlored in a 2 per cent solution of sodium bisulphite 30 minutes; then finally rinsed and blued in water containing 1 gram of "Vat Blue" in each 13⅓ liters.

Method (*B*).—The cotton was treated as in method (A), except that a solution of electrolized salt, containing 2.87 grams per liter of available chlorine was used as a bleaching agent.

Laboratory samples of the cottons were bleached by methods (a), (b), and (c). The Arizona-Egyptian cotton bleached more easily than did the Sakellaridis, and very closely resembled the Sea Island in this respect.

Samples were also bleached of each of the cottons by methods (d), (e), and (f). The results obtained by these tests were negative, as the treatment was sufficiently severe to have produced the same white on all of them.

Finally, 2-pound lots were treated according to method (B), and the results obtained matched against a series of standard whites. Table XII shows the results of this comparison.

TABLE XII.—*Bleached cotton of the respective grades and lots matched against a series of standard whites.*

	Arizona-Egyptian.				Sea Island.		Sakellaridis.		
	1	2	3	4	5	6	7	8	9
Set	3	3	3	3	3	3	3	3	3
Standard	7	8	8	7	6	8	7	7	7

The above standards consist of set No. 1, a range of yellow tints; set No. 2, a range of blue tints; and set No. 3, a range of red tints. The better the bleach obtained, the less yellow would be apparent, hence such samples would find their match in set No. 2 or No. 3. In each set there were 10 standards, varying with regular increasing intensity of tint, the higher numbers having the highest color. Hence from the above tables it will be seen that the Arizona-Egyptian in case of samples No. 1 and No. 4 gave shades equal to the true Egyptian, and in the case of samples No. 2 and No. 3 gave shades equal to the best obtained on the Sea Island.

BLEACHING YARNS.

Yarns made from the cotton designated No. 1 to 9 (p. 11) were used in the bleaching tests. The bleaching of these yarns was carried on according to methods (A) and (B). The whites obtained were matched against the standards with the results given in Table XIII. This table shows that with either method of bleaching, better whites were obtained with the Arizona-Egyptian and Sea Island than with the Sakellaridis.

TABLE XIII.—*Bleached yarns matched against a series of standard whites.*

Method.		Arizona-Egyptian.				Sea Island.		Sakellaridis.		
		1	2	3	4	5	6	7	8	9
(A)	Set	3	3	3	3	3	3	3	3	3
	Standard	7	7	7	7	7	7	6	6	6
(B)	Set	3	3	3	3	3	3	3	3	3
	Standard	6	6	6	6	6	6	4	4	4

In the laboratory tests, the deviations in the numbers were standardized on the basis of the average number of the gray, the bleached, and the mercerized, respectively. When the tensile strength of the gray yarn was compared with the results obtained in the laboratory, yarn from the same bobbins was used in each case. From these bobbins 60 yards instead of 120 yards per skein were used. (See footnote 1, p. 8.)

The tensile strength of 80/2 yarns of each of the nine kinds was taken before and after bleaching with methods (A) and (B). The results of these tests are shown in Table XIV.

TABLE XIV.—*Tensile strength before and after bleaching.*

Sample number.	Gray.			Bleach A.			Bleach B.		
	Number of yarn.	Tensile strength.		Number of yarn.	Tensile strength.		Number of yarn.	Tensile strength.	
		Pounds per skein (60 yards).	Ounces per single thread.		Pounds per skein (60 yards).	Ounces per single thread.		Pounds per skein (60 yards).	Ounces per single thread.
1	42.3	37.9	8.7	46.4	31.1	7.0	47.0	34.6	8.3
2	42.3	34.8	8.5	46.4	26.7	7.3	47.0	....	....
3	42.3	36.2	8.2	46.4	28.8	7.1	47.0	33.0	8.4
4	42.3	34.3	7.9	46.4	28.5	7.1	47.0	31.0	8.6
5	42.3	38.2	9.0	46.4	29.7	6.9	47.0	38.8	8.7
6	42.3	35.1	8.4	46.4	27.2	6.7	47.0	28.0	7.0
7	42.3	37.7	8.4	46.4	31.7	7.4	47.0	37.0	8.2
8	42.3	36.0	8.6	46.4	33.8	8.3	47.0	29.5	8.8
9	42.3	32.5	8.2	46.4	28.3	7.8	47.0	34.0	7.9
Average 1-9	42.3	35.8	8.4	46.4	29.5	7.3	47.0	33.2	8.2
Average 1-4	42.3	35.8	8.3	46.4	28.8	7.1	47.0	32.9	8.4
Average 5-6	42.3	36.6	8.7	46.4	28.4	6.8	47.0	33.4	7.9
Average 7-9	42.3	35.4	8.4	46.4	31.3	7.8	47.0	33.5	8.3

A comparison of the figures in Table XIV shows that the Arizona-Egyptian cotton was slightly weaker in the gray than the average of all, and that the Sea Island was stronger than the average of all. When bleached according to method (A) the Arizona-Egyptian was also weaker than the average and the Sakellaridis stronger. When bleached according to method (B) the Arizona-Egyptian was the weakest and the Sea Island the strongest. These deviations from the average strength, however, are not greater than the variations found between the several tests on the same yarn. Hence, this table of averages does not indicate a very serious variation in the strength.

DYEING.

Samples of the yarns were bleached according to method (B), but not blued. These samples were dyed pink and blue by the methods given below for direct and basic dyes. The results of these tests indicated no appreciable difference in the dying values of the nine cottons tested. The two methods are as follows:

Direct dyes.—The yarns were dyed in a bath containing a 0.1 per cent benzo rhoduline red B, 5 per cent of salt, and a 0.5 per cent soluble oil. The volume of dye bath equaled 25 times the weight of the goods. The goods entered the dye bath cold, and the temperature was raised to the boiling point in 30 minutes. They were boiled 15 minutes and allowed to cool in the bath 15 minutes. The light blue was dyed in the same manner, except that a 0.1 per cent benzo fast blue B N was used instead of the benzo rhoduline red B.

Basic dyes.—The goods were mordanted in a solution containing 0.015 of a gram of tannic acid in each 100 cc. The goods were entered cold; the temperature of the bath was raised to 190° in 45 minutes; it then was allowed to cool over night, rinsed and treated cold for 15 minutes in a bath containing 0.01 of a gram of tartar emetic.

The pinks were dyed in a bath containing 0.05 per cent of rhoduline red B, 0.5 per cent of acetic acid, cooled 30 minutes, then raised to 140° during 30 minutes. The blues were dyed in the same manner as the pink, except that 0.05 per cent of methylene blue B B was used.

MERCERIZING.

Samples of each of the nine kinds of yarns (60/2) were singed and mercerized collectively at one of the mills of New Bedford, Mass., and subsequently tested for their tensile strength and degree of mercerization. The tensile strength and the numbers of the yarn of all nine samples were taken before and after mercerization. The results are shown in Table XV.

TABLE XV.—*Tensile strength before and after mercerization.*

Number of sample.	Gray yarn.			Mercerized yarn.		
	Number of yarn.	Tensile strength.		Number of yarn.	Tensile strength.	
		Pounds per skein (60 yards).	Ounces per single thread.		Pounds per skein (60 yards).	Ounces per single thread.
1	31.6	48.5	11.6	33.6	57.5	16.5
2	31.6	48.0	10.9	33.6	59.9	16.7
3	31.6	49.3	11.7	33.6	56.8	17.2
4	31.6	49.9	11.8	33.6	56.9	16.4
5	31.6	51.0	....	33.6	60.4	17.9
6	31.6	48.9	11.5	33.6	57.0	18.4
7	31.6	51.4	12.1	33.6	59.8	18.3
8	31.6	51.5	12.3	33.6	59.4	18.1
9	31.6	51.3	12.1	33.6	56.5	17.3
Average 1–9	31.6	50.0	11.8	33.6	58.2	17.4
Average 1–4	31.6	48.9	11.5	33.6	57.8	16.7
Average 5–6	31.6	50.0	....	33.6	58.7	18.2
Average 7–9	31.6	51.4	12.2	33.6	58.6	17.9

It will be noticed in Table XV that the mercerized samples 1–4, inclusive, show a lower breaking strength than samples 5–6 or 7–9.

The yarns were tested for degree of mercerization by dyeing them in 1 per cent benzo purpurin 4B, 10 per cent salt, 1 per cent soluble oil for 30 minutes at 160°, volume of bath equal to 100 times the weight of goods treated. In order to determine the degree of mercerization, samples of mercerized Egyptian yarn were dyed in the same baths after dyeing the samples 1–9. These exhaust skeins furnished a means of measuring the degree of mercerization, for the better mercerized samples of cotton absorb more dyestuff and consequently leave less in the dye bath.

Table XVI represents a set of standards obtained by dyeing mercerized Egyptian yarn with the following percentages of dyestuff salt and soluble oil by method given above, benzo purpurin 4B being used as the dyestuff.

TABLE XVI.—*A set of color standards.*

Standard No	1	2	3	4	5	6	7	8	9
Dye per cent	5	4.5	4	3.5	3	2.5	2	1.5	1
Salt per cent	20	20	20	20	20	20	10	10	10
Soluble oil per cent	2	2	2	2	2	2	1	1	1
Standard No	10	11	12	13	14	15	16	17	18
Dye per cent	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
Salt per cent	10	10	10	10	10	10	10	10	10
Soluble oil per cent	1	1	1	1	1	1	1	1	1
Standard No	19	20	21	22	23	24	25	26	27
Dye per cent	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.01
Salt per cent	10	10	10	10	10	10	10	10	10
Soluble oil per cent	1	1	1	1	1	1	1	1	1

By matching the samples of yarn dyed in the exhaust baths against the above standards the results shown in Table XVII were obtained.

TABLE XVII.—*Mercerized yarns matched against color standards for degree of mercerization.*

	Arizona-Egyptian.				Sea Island.		Sakellaridis.		
Yarn samples	1	2	3	4	5	6	7	8	9
Matched standards	17+	17	17+	17	16	17−	16−	14+	15−

From Table XVII it will be seen that the Arizona-Egyptian cotton samples 1–4 gave better results in mercerizing than any of the others, the nearest approach to it being that of sample 6, Sea Island cotton.

These laboratory tests show that after bleaching, dyeing and mercerizing, the Arizona-Egyptian and Sea Island cottons were practically equal to each other and were slightly superior to the Sakellaridis Egyptian in their bleaching and mercerization properties; that they were fully the equal in dyeing properties, possibly ranging slightly in favor of the Sea Island and Sakellaridis in tensile strength.

DIFFICULTIES IN INTRODUCING A NEW VARIETY OF COTTON.

The manufacturer usually secures a contract for goods before they are manufactured, but when offering a fabric or yarn for sale, manufactured from a new kind of cotton, difficulties frequently are met with from the buyer or converter who, when placing a contract or an order for fine goods, specifies the kind of cotton required, that is, American, Egyptian, or Sea Island. In a large number of instances on cloth orders, the warp required is of American cotton and the filling Egyptian, or vice versa. The grade of cotton used is, of course, at the discretion of the manufacturer, provided he meets the requirements of contract as to the strength and quality. Manufacturers who have experimented with the Arizona-Egyptian cotton have found that it is less wasty than other cottons and that it can be utilized satisfactorily as a substitute for most purposes; but so long as the manufacturer meets his contract, the amount of waste discarded in the manufacturing processes is not primarily of interest to the converter or consumer. In fact, manufacturers are reluctant to change while their business is on a profitable basis. However, on certain classes of goods, mixtures of two different cottons are made to advantage. Because the Arizona-Egyptian is a heavy bodied cotton, it is entirely possible that the entire amount produced can be utilized advantageously if mixed properly with these other cottons in the manufacturing processes. Manufacturers claim that the sooner this cotton comes on the market in large quantities, the easier will it be to place it on a competitive basis with other long-staple cottons of similar qualities.

COMPARATIVE SPINNING TESTS MADE FROM THE CROP OF 1913-14.

Previous to the tests made in the summer of 1915, there were similar tests conducted in the summer of 1914 on cotton of the 1913 crop.[1] These preliminary tests were made on about 35 pounds of each grade of Arizona-Egyptian cotton and were run in comparison with a lap of Sakellaridis Egyptian and a lap of Sea Island cotton which had been run through the pickers in a cotton mill. There was not available a sufficient quantity of Arizona-Egyptian cotton to make these tests conclusive, nor were the Sakellaridis Egyptian nor the Sea Island cotton procured in the raw condition. It was assumed that the laps of the Sakellaridis and the Sea Island cottons had lost their usual amount of waste through the pickers and contained the average amount of waste usually present in cottons of their class when ready to be started into the cards. From this point on, the different lots were run under the same mechanical conditions without change in speeds or settings. The length of staple of the three lots was approximately equal.

The percentages of waste for the five grades of Arizona-Egyptian cotton, based on the net amount of cotton fed to the pickers, were as follows:

	Per cent.
Fancy	16. 38
Extra	16. 35
Choice	17. 44
Standard	23. 99
Medium	24. 35

---

[1] These tests were conducted at the New Bedford Textile School by Mr. Fred Taylor.

The percentages of waste discarded by the cards and combers for the Arizona-Egyptian, Sakellaridis Egyptian, and Sea Island cottons, based on the amount of cotton fed into the cards instead of pickers, were as follows:

	Per cent.
Arizona-Egyptian:	
Fancy	14. 15
Extra	15. 36
Choice	16. 16
Standard	21. 48
Medium	21. 38
Average Arizona-Egyptian	17. 70
Sea Island	19. 03
Sakellaridis Egyptian	17. 54

These tests do not seem to indicate very definitely which variety of cotton would be the best, when judged from the standpoint of percentage of waste discarded in the manufacturing processes.

The average size of the yarn produced from the three lots of cotton was 100's. The average tensile strength for the three lots was as follows:

	Pounds per skein.
Arizona-Egyptian	20. 02
Sea Island	19. 06
Sakellaridis Egyptian	19. 70

There seem to be no conclusions as to the superiority of any variety of cotton that can be satisfactorily drawn from the comparison of the tensile strength of these three lots.

The principal points of interest wherein these preliminary tests coincide with the results of the tests on the crop of 1914–15 are as follows: (1) The total amount of waste discarded in the manufacturing processes of the different grades of Arizona-Egyptian cotton bears some relation to the grades; (2) the tensile strength figures do not indicate definitely that one lot is superior to another.

A comparison of the results of the tests made on cotton of the 1913–14 and 1914–15 seasons shows that there is such a discrepancy in the amount of waste discarded from the same kind of cotton that the results of neither test can be accepted as absolutely conclusive.

SUMMARY.

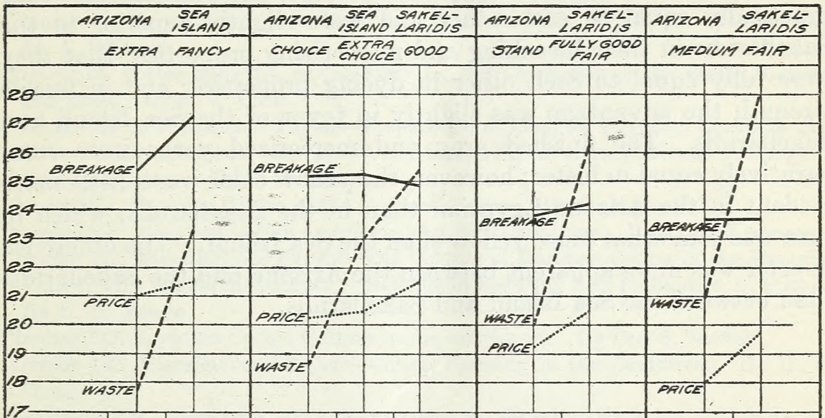
The relative waste discarded in the manufacturing processes of the four grades of Arizona-Egyptian cotton tested was as follows: Extra, 17.69 per cent; Choice, 18.56 per cent; Standard, 20 per cent; Medium, 20.90 per cent.

These tests show that with respect to grade the four bales of Arizona-Egyptian cotton were proportionately less wasty than the two bales of Sea Island of Georgia, and the two bales of Sea Island were proportionately less wasty than the three bales of Sakellaridis from Alexandria, Egypt.

There was no relation in the price of the different kinds of cotton to the percentages of waste discarded in the manufacturing processes. The reverse condition developed, namely, Arizona-Egyptian cotton was estimated to be lower in commercial value than Sea Island, and Sea Island to be lower than Sakellaridis, when comparing equivalent grades.

There was no significant relationship between the tensile strength of the respective grades of Arizona-Egyptian cotton.

The difference in the tensile strength of yarn made from the three kinds of cotton was practically negligible. Considerable deviation occurred varying slightly in favor of first one kind and then another, but, as a whole, resulting somewhat in favor of the Sakellaridis Egyptian cotton, with the Sea Island coming second. However, the tensile strength for the highest numbers of yarn was in favor of the Sea Island cotton.



	ARIZONA	SEA ISLAND	ARIZONA	SEA ISLAND	SAKELLARIDIS	ARIZONA	SAKELLARIDIS	ARIZONA	SAKELLARIDIS
	EXTRA	FANCY	CHOICE	EXTRA CHOICE	GOOD	STAND	FULLY GOOD FAIR	MEDIUM FAIR	
PRICE	.21	.215	.2025	.205	.215	.1925	.205	.18	.1975
PERCENTAGE OF WASTE	17.69	23.42	18.56	23.05	25.36	20.00	26.38	20.90	27.97
NO. OF YARN	80	80	80	80	80	80	80	80	80
BREAKAGE	25.34	27.45	25.23	25.25	24.97	23.87	24.26	23.66	23.66

FIG. 2.—Comparison of the prices of raw cotton, waste discarded in the manufacturing processes, and the tensile strength of the yarn in pounds per skein of 120 yards each for Arizona-Egyptian, Sea Island, and Sakellaridis Egyptian cottons.

(The figures at the left indicate the cents per pound for the price, percentage for the waste, and pounds per skein for the breaking strength.)

Figure 2 presents graphically the comparative prices of the three kinds of cotton, the percentages of waste of each kind discarded in the manufacturing processes, and the tensile strengths of the yarn made from them. The graph is arranged for comparing the grades that are practically equivalent. The table at the bottom of this graph gives the figures referred to which are taken from previous tables and placed here for ready reference. The figures on the left-hand margin indicate cents per pound for the price, percentage for the waste, and pounds per skein for the breaking strength. Number 80's yarn was taken for the comparison. The graph shows that there is no significant relationship between the prices of the different cottons and the percentages of waste and tensile strength. It shows that our domestic cottons are equal to, and in most respects superior to, imported cottons. It indicates also the preferences of manufacturers which must be changed in order to introduce satisfactorily any new cotton.

The laboratory test indicated that after bleaching, dyeing, and mercerizing, the Arizona-Egyptian and Sea Island cottons were practically equal to each other and were slightly superior to the Sakellaridis in their bleaching and mercerizing properties; that they were fully equal to each other in dyeing properties; and in tensile strength the advantage was slightly in favor of the Sea Island and Sakellaridis. The finished grey and mercerized yarns were comparatively equal in luster; however, the yellow color was a little more evident in the Arizona-Egyptian than in the Sakellaridis, which in turn was somewhat more yellow than the Sea Island. The difference in color was more apparent between the Arizona and the Sakellaridis than between the Sea Island and Sakellaridis.

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